1994 ITEA Symposium
Session #4. Space System Test and Evaluation
October 5. 1994

Space Hardware Test Effectiveness

JPL/NASA
Produce Assurance Program Assessment Project

presented by

D. W. Lewis
Spacecraft Environmental/ReIiabiIity
Engineering Group

JPL

This presentation is based on research conducted
at the California Institute of Technology. Jet Propulsion Laboratory. Pasadena. CA, sponsored by the
Payloads and Aeronautics Division (QT) of **NASA'S** Office of Safety and Mission Assurance

INTRODUCTION & BACKGROUND

The Winds of Change

- the past is a hard act to follow
- the missions are more difficult
- the funding is constrained
- the development guidelines are different

The Basic Problems

- the separation of causes & effects
  (or the nice-to-do from the required)
- the loss of the familiar
- the unknowns of the new

The Reassessment of the Assurance Processes

- what are we doing ?
- how well are we doing ?
- what should we be doing ?

REPORTS OF FLIGHT ANOMALIES

Indication of Things That Were Missed

- in the mission design
- in the equipment design
- in the test program
- in the training (design & operations)

Indication of Performance Trends

- for various types of equipment
- for the use of redundancy
- for lifetime estimates (failure rates)

Indication of Assurance Program Effectiveness

- compared to expectations
- compared to earlier flights
- compared to other programs
  (at JPL, NASA, DoD, & Commercial)

REPORTS OF PREFLIGHT TEST ANOMALIES

Used To Develope Confidence

- in the flight equipment design
- in the workmanship
- in the performance margins
- in analytical modeling

Used To Establish Trends

- in equipment failures (type & rate)
- in test levels & durations
- in **ground/flight failure** correlations

Used To Indicate Test Effectiveness

- for various simulated environments
- for various test tailoring techniques
- for the test program content & **adequacy**

EVALUATION OF FLIGHT PERFORMANCE

Provides A Basis For Comparisons

- of mission performance to causal effects (such as cost & complexity)
- of payload development methods (in-house vs. contracted)
- of assurance philosophies (payload class, development center)
- of flight system design approaches

Provides The Significance Of Failures

- to the use of redundance
- to the use of work-arounds
- to the functional interactions of systems

Provides Guidance For Improvements

- in defining mission/science objectives
- in maintaining development focus
- in tailoring assurance requirements
- in making risk/cost/benefit trades

THE ROLE OF RISK WITHOUT FAILURE

Development Risk

- management of cost/schedule/scope
- the cost of implementing assurance
- the costs of complexity & conservatism
- trend from custom-made to inherited or commercial equipment

Performance Risk

- the need for a "balanced" assurance program (more than just electronics)
- the measurement & manipulation of risk
- the calibration of lifetime predictions

Programmatic Risk

- the paradox of fixed cost & variable scope
- the paradox of low cost & high expectation
- the paradox of lower funding for assurance & the insertion of new technology

SITUATION RECAP

Looking At The Past

- comprehensive assurance programs evolved
- they were largely successful
- they were expensive

Looking At The Present

- comprehensive programs are too expensive
  (minority position disagrees)
- relative importance of assurance program elements is difficult to quantify
- the new missions are equally difficult

Looking At The Future

- a decline of custom made equipment
  (less control of design & parts)
- a trend toward more assurance testing
  (with emphasis on performance margin & time-between-failure tests)